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MACROECONOMIC DECISION MODELS WITH SPECIAL EMPHASIS ON THEIR APPLICABILITY IN LESS DEVELOPED AREAS

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H.1.

Macroeconomic Decision Models

with special emphasis on their applicability in less developed areas

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0. Introduction

The development problem in less developed areas has a variety of special aspects, as listed in Part III of the United Nations' "Revised Information Bulletin" (E/CONF.39/INF.1/REV.1). These special aspects have in the past attracted considerable attention, but they need much closer study as separate branches of the development problem. One generel aspect of the problem has attracted less attention and is, in my opinion, a minimum factor in development studies today, namely a rational scientific analysis of the way in which the various special aspects gear into each other. The economic coordination problem has, as I see it, been approached in a too simple manner.

The popularity of these traditional approaches is, it seems, due more to their simplicity and therefore ease of theoretical handling than to their realistic and practical use in development policies. To be specific I may mention a few of the shortcomings of the simple approaches to the economic coordination problem.

When attention is focused on such simple concepts as the savings rate and the output-to-capital ratio and forecasts of these magnitudes, one cannot take adequately account of the very thing that is vitally important in developing areas, namely an exact comparison of the various specific investment projects that might be considered. A large number of investment projects will have to be considered and compared, taking account of all their foreseable effects, direct as well as indirect. As examples of such effects may be mentioned: (a) The timeshape of the input-needs (domestic and foreign) for the execution of each specific big investment project or specific group of smaller projects. (b) The timeshape of the increase in production capacity which will follow if and when the project or group of projects is accepted. (c) The time shape of the infra-effect, i.e. the effect which the project or group of projects may have on the current account input-coefficients or other essential coefficients. (d) The effects, direct as well as indirect, which the adoption of the project or

group of projects will have (in the construction period and in the subsequent operation period) on the flow of purchasing power to private households and therefore on private demand for consumer goods. All these aspects - and several others - of the investment activity must be taken account of explicitely and simultaneously when one is aiming at the "optimal utilization of ... resources" (p.3 of the "Revised Information Bulletin").

A current account input-output table in absolute figures based on data for previous years is very useful as a provisional description of the structure of the economy. But in a developing area where Government initiative is the key-note of the problem, it is misleading to convert such a table to a table of coefficients and in the traditional way (through a matrix inversion) to use these coefficients in order to derive the total production in each production sector from a list of final demands. This procedure is inadequate for a number of reasons. (a) It does not take account of the various capacities of production that will exist in each year within the planning horizon (these capacities are determined by the specific investment decisions made). (b) It does not take account of the infra-effect (which also depends on the specific investment decision made). (c) It does not take account of the substitution effect among different types of input (for instance the use of alternative sources of energy). (d) The final demands cannot be considered as data but must be considered as variables which, together with other variables, are to be determined through a comprehensive programming analysis.

Growth models (even if built on a sectorial break down) are inadequate. We need instead operational decision models with explicite specification of the large number of parameters that are subject to Government control and decision, for instance acceptance, postponement or rejection of specific big investment projects or specific groups of smaller projects; decisions on various current account operations such as the consumption policy for specific types of consumer goods etc.

Studies of the balanced-growth type (leading for instance to the time path nicknamed the "Turnpike")are inadequate. The very concept of "balance" can only be defined in a realistic way through a rational dynamic programming approach that includes simultaneously all the above aspects, at least in an approximate way. And if such an approach is followed, there is no need for introducing the concept of "balance".

On the basis of my theoretical studies and the experience gained during several stays in less developed countries (Egypt and India) I have attempted to work out a comprehensive scheme of optimal programming including simultaneously all the aspects mentioned above. Within the compass of the present short paper I can do nothing more than to indicate very briefly under 16 paragraphs the content of this analytical scheme.[1]

1/ The scheme is considered in some detail in my paper Preface to the Oslo Channel Model. ASEPELT, 1, 248-286. North-Holland Publishing Company, Amsterdam (1962). More details will be given in a paper to appear in the research series of Accademia Nazionale dei Lincei, Roma.

1. The difficulties and the seriousness of the problem

In underdeveloped countries that strive to achieve rapid economic progress, one is nearly always confronted with the same common pattern of difficulties and conflicting goals. To create employment and raise living standards as quickly as possible in a rapidly increasing population, one starts more or less by force all sorts of economic activities. Improvements in agriculture, industrial developments in light industries as well as in heavy industries like steel, fertilizers, electricity production etc. Since all this activity means spending lots of money, an inflationary pressure emerges with heavy drain on foreign reserves. Purchasing power in the hands of consumers is increased. Social reforms such as the redistribution of land tend in the same direction. By trying to solve one problem one creates several new problems. The whole picture is bewildering and it is hard to know precisely what course to follow. In this situation optimal programming is indispensible.

2. The nature of foreign aid

One of the worst things that can happen to an underdeveloped country is to receive foreign aid with political strings attached. But economic strings may be equally disasterous. Sometimes they are wrapped up in financial forms that are not easily discernable.

Private investments made in a developing country by a foreign company in order that this company can make a profit, has nothing to do with "aid". This, of course, does not mean that a developing country may not find it advantageous to make a contract with a foreign company, say, for the setting up of a factory or for prospecting for oil or other natural resources. This is simply an advantageous transaction similar to other trade transactions with foreign countries. The same applies to loans given on a strictly commercial basis. Real aid is something different. It consists of direct gifts (with neither political nor economic strings attached) or loans that are given on particularly favourable terms (and with no strings attached).

3. The planning model must be dynamic. The principle of moving planning. Committed - to vs. decisional elements

The planning model must be dynamic in the sense that each variable in each year in the foreseable future must be considered as a separate magnitude. And a clear distinction must be made between the magnitudes that are already committed - to through previous decisions and those that are still decisional in the sense that they depend on the particular decisions to be made in the year considered. Each year a complete new plan (say a five or seven year plan) should be worked out, taking account of new data (perhaps changed preferences) and what has now become committed -

to through last year's decisions. This is the principle of moving planning.

4. The planning model must be operational. The insufficiency of prices as instruments of planning

The planning model must be operational in the sense that it brings out explicitely the parameters that are subject to Government control and decision, as stated in the introduction. Detailed theoretical analyses as well as practical experience prove that prices are insufficient as instruments for steering the economy towards the desired constellation.

5. Planning period vs. repercussion period. The truncation effect

The planning period is the span of years (say 5 or 7) for which one considers in detail the effects of decisions. In order to reach the decisions it is, however, necessary to have an open eye also for certain economic repercussions that will follow over a longer period after the lapse of the planning period, even though these repercussions are not considered in great detail (electric power stations etc. may last perhaps 50 years or longer). This more extended period is the repercussion period. The distinction between these two periods produces a truncation effect in planning. The ensuing problem may be solved with sufficient accurancy through a suitable formulation of the preference function.

6. The selection problem vs. the implementation problem

In the selection problem one seggregates for consideration certain types of conditions that are of a particularly basic sort: Accounting relations, technical conditions of production and capital investment (including the possibility of substitution between certain kinds of input), the bounds on the variables that are due to the capacities of production in any given year, the basic laws in the consumers behavior etc. Mathematical programming is most promising when applied to the selection problem.

When the optimum timepath of the economy from the selection viewpoint is determined, one considers what kinds of specific institutional, administrative and monetary measures will be needed in order to bring about the optimum evolution of the economy (in the years under consideration). This is the implementation problem. To revert the order of these two problems is to put the cart before the horse.

7. Planning on the establishment and commodity level vs. planning in more aggregated terms

If a very detailed form of planning is desired, it will have to be done throughout on the establishment and commodity level. But this is so formidable a task, both computationally and from the viewpoint of data collection that some form of aggregation has to be made, at least for such establishments and commodities

that are not of dominating importance.

8. The preference function and the cooperation between responsible politicians and analytical experts

Any programming technique must be based on a definition of the preference function. This admittedly is a difficult problem that needs to be studied in all seriousness. During the last years I have worked so much both on the theoretical and on the practical aspects of this that I have been able to reach a rather definite opinion. I am convinced that the preference function problem for an economy at large can be solved when it is approached in an intelligent and cautious way. This opinion is based not least on extensive interviews with leading policy makers.

The preference function cannot be formulated in one stroke. It can only be done through a series of attempts based on continuous co-operation between the responsible authoriries and the analytical experts. A series of tentative solutions with different alternative formulations of the preference function (and of some of the bounds in the problem and other side conditions) is needed. Compare also paragraph 10.

9. The nature of bounds

For most of the variables we must impose lower and|or upper bounds. These bounds may be of different sorts. For instance a lower bound on the production in each production sector. Conceptually this bound is at least zero, but as a rule it will for political or other reasons be much higher. The condition that actual production in any sector shall never surpass the existing capacity leads to the introduction of a slack variable which is bounded on one side. It will as a rule be found convenient to supplement the continuous definition of the preference function by bounds on the variables in terms of which the preference function is expressed.

10. The parametric aspect of programming. The peak load on foreign indebtedness

It will be necessary to consider a lower (possibly zero) bound for investments in each given direction and also an upper bound due to the limited stockpile of products in each direction. Several solutions may be run with different values of the upper bounds to investigate the usefulness of additional project making in the various directions. Compare paragraph 15 on project guidance.

Last but not least it will be necessary - for political reasons or reasons of the foreign credit market - to impose an upper bound for the peak load of foreign indebtedness over the foreseable future. This latter bound is extremely important. Several solutions should be run, each with a different value of this bound.

The changes of bounds here considered make the programming parametric. Compare also paragraph 8.

11. Private consumer demand as determined by the flow of purchasing power from production sectors to households

The way in which this aspect of the problem is incorporated in the analysis is discussed in a number of previous papers.[2]

12. The substitution in current production inputs taken account of through input substitution rings in approximately equivalent factors

When we speak of the requirement which a certain sector, say No.k, has for a certain kind of input, we cannot in general assume that this requirement always has to be delivered from a particular one of the other sectors. This applies for instance to energy. We will assume that there may be a ring of other sectors say Nos. $\alpha, \beta \ldots \gamma$, from which the supply may come. We will assume that the individual sectors within the ring are equivalent in the sense that a definite quantity of the product of any given one of these sectors can replace a definite quantity of the product from any given one of the other delivering categories in the ring. The ring product being thus defined, we will assume that sector k has a technically well defined requirement for the ring product as a whole.

In symbols we can express these assumptions by saying that in the year t, the deliveries from the delivering categories $\alpha, \beta \ldots \gamma$ to the sector k are defined through the following ring equation

$$(12.1) \qquad \sum_{h=\alpha,\beta\ldots\gamma} x^{xrt}_{hk} x^{t}_{hk} = x'^{t}_{rk} x^{t}_{k}$$

where x^{t}_{k} is total production in sector k in year t, x^{t}_{hk} is the delivery from h to k in this year, the x^{xrt}_{hk} are given equivalence coefficients inside the ring r and x'^{t}_{rk} is the input coefficient from ring r to sector k.

From a formal viewpoint it is more convenient to extend in (12.1) the summation to all delivering categories, and simply put the equivalence coefficient x^{xrt}_{hk} equal to zero for those delivering categories h that do not belong to the ring r. With this convention the ring equation can be written in the general form

$$(12.2) \qquad \sum_{h=all} x^{xrt}_{hk} x^{t}_{hk} = x'^{t}_{rk} x^{t}_{k}$$

where "all" indicates all technical delivering categories (production sectors, primary inputs and complementary imports).

For each receiving sector k there will exist a definite number of rings, each defined by a ring equation of the form (12.2)

The fixed coefficient approach with no room for substitution between input categories can be expressed as the special case of (12.2) where there is one ring

2/ Ragnar Frisch, From National Accounts to Macroeconomic Decision Models. Memorandum of 27 August 1953 from The University Institute of Economics, Oslo (also published in the series brought out by the International Association for Research in Income and Wealth). Ragnar Frisch, Main Features of the Oslo Median Model, Memorandum of 10 October 1956 from the University Institute of Economics, Oslo (also published in Russian (1961) in the series edited by academician Nemchinov)

corresponding to each delivering category, and in each such ring all the equivalence coefficients are zero except one, namely the one corresponding to the delivering category considered. This particular equivalence coefficient may then conventionally be put equal to 1. If the rings are numbered according to the delivering category in question, the equation (12.2) then reduces to

$$(12.3) \qquad x^t_{hk} = z'^t_{hk}\, x^t_k$$

which is the simple input coefficient assumption with no substitution possibility.

It is easily seen that the ring structure (12.2) will in general leave us with more degrees of freedom than the simple input coefficient assumption (12.3). For instance if for a given k (12.3) is assumed for all input categories h except three and the assumption for these three is replaced by a single ring equation, we have two more degrees of freedom than we would have had if (12.3) had been assumed for all input categories. The introduction of substitution rings does not destroy the linearity of the set up, it only increases the number of degrees of freedom.

13. Substitution effect in private consumer demand, in government current input and in geographical export directions

These effects may be handled by a similar procedure as that explained in paragraph 12. This will not destroy the linearity of the set up.

14. The investment starting

The volume of the starting in the investment channel No. g with delay d is denoted H^d_g. These variables are fundamental. The magnitude H^d_g does not denote the investment expenses that will actually have to be incurred in the starting year, i.e. in the year d+1 (t=1 being the first year of the plan), but it indicates the total expenses (reckoned in volume figures) over all the years taken together that will be needed in order to complete the investment that is considered for starting in the year d+1. The magnitude H^d_g does not express something that has happened or something that will necessarily happen, but it is a decisional parameter. We may decide to make H^d_g smaller or larger, or perhaps put it equal to zero. The essence of the problem is that from our decision on the size of H^d_g will follow a number of consequences that must be studied (the time shape of the input needs for completing project g, the time shape of the increase in capacities etc.). How large we should make H^d_g is a problem which is part of the general programming analysis.

15. The project description. The list of projects. Project guidance

An investment project is defined through a description worked out according to a scheme with thorough specification of the data which are required to find out what the repercussions on the economy will be if and when it is decided to start the project.

The data contained in the project description can only be concerned with the repercussions that are directly visible and therefore can be given by the technicians connected with the elaboration of the project. The infinite variety of indirect repercussion will only appear when the project - with explicit formulation of the two alternatives: acceptance or rejection - has been incorporated in a decision model that has been solved by the overall planning experts.

There are four types of data to be included as direct repercussions in a project description. First the parameter H_g^d that indicates the size of the project and its phasing, i.e. the year when it might be started. Second, a set of coefficients describing the carry-on-activity, i.e. the investment inputs that have to be made into the project in the course of the construction period. Third, a set of coefficients describing the effects which the project will have on the capacities of production when the fruits of the projects - if and when it is started - begin to emerge. It is essential to take account of the time shape of this capacity effect. Fourth, a set of coefficients describing the infra-effect of investments, i.e. the effect which an investment project may have on the coefficients of the model.

Details about the current account inputs and outputs that will be connected with the project during its subsequent state of operation will depend on many things that cannot be finally decided upon until after a complete and overall programming solution has been obtained (unless one is prepared to make many simplifying assumptions). Final details about current account operations can therefore not be given in the project description but special types of information about this should be given.

Rational planning at a national level can, of course, not consist simply in applying mathematical programming techniques to a decision model built on any given list of investment projects. For the possibility of obtaining a really high value of the preference function it is essential that investment projects of the right kind are available. To increase the chance of having valuable projects included in the list of projects which is taken as a datum in the mathematical programming, the planning authorities should issue ahead of time what may be called a project guidance built on what project properties have proved useful in previous complete solutions or in solutions of pilot investigations. But this being said, I want to add that it is dangerous to go too far in this direction. We must rely on the creative imagination of all layers of the whole population. And for best results the projectmakers should not be put in a Procrustean bed. Everybody should be encouraged to bring forth new ideas however wild they may look. But a collection of ideas is certainly not enough. One will need a systematic method for distinguishing between what is valuable and what is useless from the viewpoint of the preferences of the policy makers. Only scientific programming can provide such a criterion.

16. Regional planning.

In a concrete and realistic form of national planning it is impossible to disregard the regional aspect. The aims of national planning will indeed always to a smaller or larger degree be concerned with the development of certain underdeveloped parts of the country. And we have to consider the fundamental problem of an optimal development of the transportation network and the location of industry. And this in turn is connected with all sorts of micro-regional prlblems involving such questions as social layers, housing problems, shopping and entertainment centres, commuting lines between living place and working place etc.

I have no faith in a planning system where each region - defined in a more or less conventional way - is left free to submit, according to its own ideas, a suggestion for a plan - investment pland and|or plan for current account operations - within its border, attempting subsequently to "co-ordinate" these regional plans at the top level by trial and error or rounds of "iterations" by consultations between the top level and the regional authorities. For effective planning one must start by a rather definite frame to be prescribed for the subsequent detailed regional - or even enterprise - plans to be prepared at the lower levels. And this top level (necessarily aggregated) plan frame must be worked out by a simultaneous and explicit programming technique. This requires a specific definition of a pattern of theoretically interlocking centres.

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